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PRIORITY DOCUMENT

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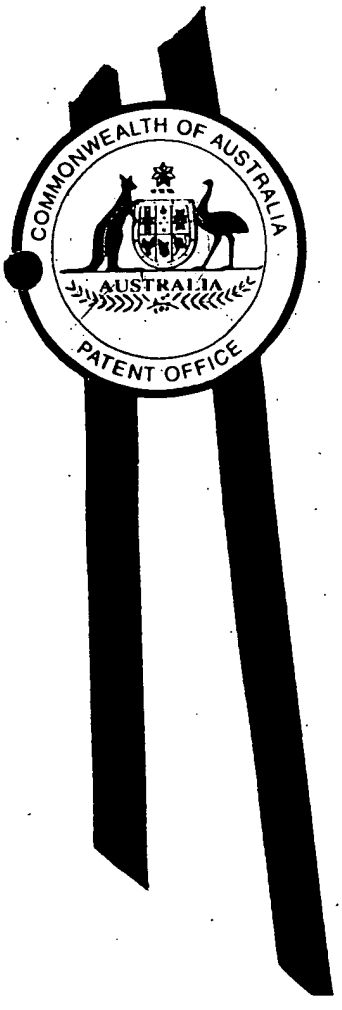

WITNESS my hand this
Nineteenth day of April 2000

L. Mynott

LEANNE MYNOTT
TEAM LEADER EXAMINATION
SUPPORT AND SALES

PATENTS ACT

PROVISIONAL PATENT SPECIFICATION

TITLE: METHOD AND APPARATUS FOR INSERTION OF A ROCK BOLT

THE INVENTION IS DESCRIBED IN THE FOLLOWING STATEMENT:

METHOD AND APPARATUS FOR INSERTION OF ROCK BOLTS

BACKGROUND

The present invention relates to insertion of rock bolts used in applications such as but not limited to underground mining. More particularly, the invention relates to an automatic drilling and injection head and a method of use thereof for automatic installation of of self drilling rock bolts thereafter secured by preselected anchoring compounds.

Rock bolts are commonly used as anchors for securing rock strata to prevent unwanted collapse during operations such as mining, excavation and the like. They are a proven means of securing rock masses in underground excavations and road tunnelling which might otherwise be in danger of collapse. Efficient installation of rock bolts is a critical facet of mining operations and it is desirable that this non productive part of mining activities be done as speedily as possible.

The concept of rock bolting involves the installation of a bolt in a predrilled hole in rock whose length is longer and whose diameter is slightly larger than the diameter of the rock bolt inserted therein.

PRIOR ART

There are in existance a wide variety of rock bolts and drilling machines for insertion of said bolts. The drilling machines employ drill rods with a cutting tip or drill bit on the leading end of the drill rod. The drill bit is usually larger in diameter than the drill rod to ensure a hole diameter at least slightly larger than the diameter of the drill rod. In order to drill a hole, the drill rod is rotated and urged against the rock face to initiate penetration.

In accordance with conventional methodology, most drill rods use air or water as a flushing fluid to flush rock cuttings from from the drill hole during drilling. The flushing fluid is normally pumped through a central hole in the drill rod exiting the cutting tip then flowing out of the drill hole between the sides of the drill rod and the rock bolt hole thereby removing the rock cuttings

from the hole during the drilling operation. The hole flushing clears the hole to accommodate the anchoring compound which is normally inserted manually after drilling. Whilst all drills employ rotation and axial thrust some additionally use impact drilling for very hard rock. Drilling into softer rocks such as sandstone will generally only require rotation and thrust. Hole drilling speed is a function of the type of rock, drill bit material and configuration and axial force applied during drilling. After drilling is complete rock bolts are inserted once the drill rod has been withdrawn. There are two broad categories of rock bolts which are differentiated by the manner of engagement between bolt and rock. Bolts in the first category rely on frictional engagement between the bolt and at least a portion of the wall of the pre-drilled bolt hole. Bolts in the second category rely for their anchorage on grouting between the rock wall and bolt. The grouting compound will either be chemical or cement based.

Friction bolts rely on expansion of an associated member such as a sleeve which is engaged for example by rotation of a nut after insertion of the bolt in its hole, whereupon the sleeve engages the wall tightly to resist unwanted withdrawal. Bolts of this type include expansion shell bolts , inflating bolts and split set bolts.

Grouted rock bolts rely entirely on the integrity of the grouting compound which is inserted into the bolt hole once the hole is drilled. Maximun engaging strength is not achieved until the grout has set and has formed a solid anchor around the rock. A typical grouting compound is polyester resin although other compounds are used.

The coal industry commonly uses grouted rock bolts using resin anchors. The resin is held in cartridges which are inserted into predrilled bolt holes prior to insertion of the bolt. The resin cartridges are filled with resin mastic and resin catalyst and are typically 500 mm to 1500 mm in length. They must be of a diameter smaller than the bolt hole to enable insertion.

According to conventional methodology the steps involved in insertion of a resin anchored rock

bolt are as follows:

a) drilling a hole of a diameter which is larger than the diameter of a bolt to be inserted;

b) withdrawing the drill rod from the hole;

c) manually inserting the resin cartridge;

d) inserting the bolt into the hole such that the bolt engages the resin cartridge and urges it to the back of the hole;

e) rotating and advancing the rock bolt such that the bolt penetrates the cartridge causing mixing of the cartridge contents (mastic and catalyst);

f) urging the bolt to full penetration whilst continuing rotation of the bolt;

g) allowing resin to cure and harden; and

h) tightening a nut on the proximal exposed end of the bolt to securely engage said bolt.

Whilst the above described method, used in various forms over the past twenty years, results in effective anchorage of rock bolts in underground mining applications, the process described is labour intensive, time consuming and therefore costly and is susceptible to poor quality control. There has been a long felt want in the mining industry for more efficient installation of bolts of the type which rely on grouting for anchorage, to reduce the time and labour component disadvantages of the present methodology.

Attempts have been made to address the aforesaid problems in resin ahchored bolt installations by using self drilling rock bolts of the type described in patent application PCT/AU91/00503.

One such attempt involved the use of self drilling hollow rock bolts to the obviate the step of pre-drilling followed by withdrawal of the drill prior to insertion of the bolt. The self drilling bit functions as a combined drill and bolt. During self drilling, the hole is flushed with water to expel rock debris until the bolt has reached maximum depth whereupon the fluid is turned off. A grouting compound is then inserted into the space between the bolt and hole wall until the

available space is occupied by the anchoring compound which could be resin or cement grout. Cement grout has major advantages over resin in that it can be mixed in a machine then pumped into the rock bolt hole. As the curing time for the cement grout is typically several hours, it is proceedurally simple to mix and pump cement grout and flush hoses and the machine before curing.

The major disadvantage of cement grouting is that the cement takes several hours to cure which is unacceptable in the coal industry. Resin anchored bolts have the advantage that the resin cures in about 20 seconds but this fast setting may cause problems of clogging in the resin delivery and mixing system once the mastic and catalyst, which are initially separated, have thoroughly mixed.

INVENTION

The present invention seeks to ameliorate the aforesaid prior art disadvantages by providing a method and associated apparatus for installing self drilling rock bolts which prevents clogging of the resin delivery and mixing system. More particularly, according to one embodiment, the invention comprises a drill head adapted for releasable attachment to a drilling apparatus, wherein the drill head includes means to receive a proximal end of a self drilling rock bolt having an internal cavity and further comprising means to enable injection through said internal cavity of resin grout comprising mastic and a catalyst; wherein said mastic and said catalyst whilst present in said drill head are separated until co injection into said internal cavity of said bolt, whereupon mixing of said mastic and catalyst occurs to form a resin in which said bolt anchors; wherein the resin is injected into said cavity until it exits an opening in a distal end of said bolt and fills a space between the exterior of said bolt and the wall of said hole.

It is one object of the invention to providea drill head for adaption to a drilling machine which allows the normal actions of rotation , axial thrust, water or air injection as well as injection through a bolt of a grouting compound. It is a further object to provide an improved injection

system for flushing rock cuttings during drilling.

According to an apparatus aspect, the present invention comprises;

a drill head capable of attachment to a drilling machine for insertion of rock bolts into rock strata;

the drill head comprising;

a base block including means to facilitate said attachment to said drilling machine;

drive means for driving a spindle having a socket at one end which receives a proximal end of a rock bolt including an internal cavity;

an injection assembly including at least one internal passage for retaining a grouting compound, wherein, when said rock bolt is inserted in said socket said at least one passage is in communication with said internal cavity in said rock bolt; whereupon said injection assembly operates to inject a predetermined quantity of said grouting compound into said internal cavity of said bolt.

Preferably, the drill head further comprises means enabling injection through passages therein of water into the bolt hole to evacuate rock debris form the hole.

According to a preferred embodiment, the injection assembly has two concentric passages each of which contains a separate grouting compound, wherein said passages are disposed so as to keep the grouting compounds separate until the compounds exit said passages and enter the internal cavity in said rock bolt whereupon they mix to complete the grouting resin.

Preferably,the grout is injected until it exits the internal cavity of the bolt via a distal end and fills a space between an outer surface of the bolt and the wall of the hole in which the bolt is placed.

In another broad form of the apparatus aspect, the present invention comprises;

a drill head capable of attachment to a drilling machine for insertion of rock bolts into rock strata;

the drill head comprising;

a base block including means to facilitate said attachment to said drilling machine;

drive means for driving a spindle having a socket at one end which receives a proximal end of a rock bolt which includes an internal cavity;

an injection assembly including at least one internal passage for retaining a grouting compound, wherein, when said rock bolt is inserted in said socket, said at least one passage is in communication with the internal cavity in said rock bolt; whereupon said injection assembly operates to inject a predetermined quantity of said grouting compound into said internal cavity of said bolt; wherein the drill head further comprises means enabling injection through passages therein of water into the bolt hole to evacuate rock debris form the hole; and wherein

the injection assembly has two concentric passages each of which contains a separate grouting compound, wherein said passages are disposed so as to keep the grouting compounds separate until the compounds exit said passages and enter the internal cavity in said rock bolt whereupon they mix to form a grouting resin.

Preferably, the grout exits the internal cavity of the bolt via a distal end and is injected until it fills a space between an outer surface of the bolt and the wall of the hole in which the bolt is placed.

In another broad form the present invention comprises;

a drill head capable of attachment to a drilling machine for insertion of a rock bolt into rock strata; the drill head including;

a sprocket for receiving an end of said rock bolt which includes an internal cavity,

an injection assembly including a passage for retaining a grouting compound and which when said bolt engages said sprocket is placed in communication with said internal cavity of said bolt;

wherein the injection assembly injects said grouting compound into the internal cavity of said bolt at least until said compound exits said internal cavity of said bolt and engages a wall of a hole in which said bolt is inserted.

Preferably, the grouting compound is injected until it fills the space between the exterior of the

bolt and the wall of the hole in which the bolt is inserted.

In the broadest form of the apparatus aspect the present invention comprises;

a drill head having an injection assembly adapted to enable injection of a grouting compound from a passage in the drill head and into a bolt hole via an internal cavity in a rock bolt which communicates with said passage when an end of said bolt engages said drill head such that said passage and said internal cavity are substantially in alignment.

In one broad form of the method aspect the present invention comprises;

a method of insertion of a self drilling rock bolt in a rock strata using a drilling machine to which is attached a drill head; wherein the method comprises the steps of ;

a) placing said drilling machine in alignment with a location at which a bolt is to be inserted;

b) taking a rock bolt having an internal cavity;

c) placing an end of the rock bolt in a sprocket on said drill head;

d) advancing the drill head such that a distal end of the bolt engages rock into which the bolt is to be inserted;

e) rotating the bolt under the action of drive means associated with said head and maintaining an axial force such that the bolt self drills a hole in said rock strata;

f) during drilling, flushing the hole with a fluid such as water to remove unwanted rock cuttings;

g) injecting a grouting compound from at least one passage in said head and into the cavity in said bolt;

h) continuing said injection of said compound at least until said compound exits the cavity in said bolt and enters an opening in the bolt hole between the wall of said hole and the exterior of said bolt.

According to a preferred embodiment, the method comprises the further step of ; prior to

injecting the compound into the cavity in said bolt, advancing an injection nozzle into sealing engagement with a proximal end of said bolt thereby allowing direct communication between the passage in said head and the cavity in said bolt

In another broad form of the method aspect the present invention comprises; a method of grouting a rock bolt inserted in a rock strata using a drilling machine incorporating a drilling head; wherein the method of grouting comprises the steps of;

a) after a rock bolt has been placed in situ, advancing an injecting nozzle of an injection assembly incorporated in said head until it reaches sealing engagement with a proximal end of the rockbolt;

b) injecting a grouting compound from a passage in said injection assembly into an internal cavity in said bolt;

c) continuing said injection until the grouting compound exits said internal cavity of said bolt and fully occupies a space formed between the exterior of said bolt and the wall of said hole;

d) retracting said nozzle away from sealing engagement with said bolt.

DETAILED DESCRIPTION

The present invention will now be described in more detail according to a preferred but non limiting embodiment and with reference to the accompanying illustrations wherein;

Figures 1(a)-(f): shows various steps for insertion of a rock bolt according to the prior art methodology;

Figure 2 : shows an isometric exploded view of a rock bolting installation assembly with a drill head according to one embodiment of the invention.

Figure 3: shows an enlarged cut away view of a drill head according to a preferred embodiment of the invention.

Figure 4: shows a cross sectional view of the drill head of figure 3 adapted internally in the drilling configuration;

Figure 5 shows the drill head of figure 3 adapted internally in the grouting configuration;

Figure 6: shows the drill head of figure 3 adapted internally for water and injection shut off.

Figure 7: shows a cross section of a bolt when fully installed.

Drilling machines employ a variety of different systems to apply rotation and thrust to drill rods. Drilling machines usually have some form of drive chuck which can either be a screw thread, a square drive or hexagonal drive chuck which fits a matching screw, square or hexagonal section of the drill rod.

In long hole drilling, where multiple drill rods are used it is necessary to attach several drill rods together and pass them through the drilling head on the drilling machine. In this application an offset drive head may be used where the drive is hollow and is offset from the main drilling motor itself. The offset drive head is normally driven by a gear system or by a chain from the drill motor.

A flushing system is employed to remove rock cuttings from the drilling operation at the drill tip. For this purpose water or air may be used or a combination of both forming a spray mist.

Referring to figure 1a-f there is shown a drilling rig configured for the various stages of operation of installation of a rock bolt according to a prior art method. Figure 1a shows drilling rig 1 engaging rock face 2 via plate 3. The rig comprises head 4 which which includes a drill chuck 5 which receives drill steel 6. Whilst drilling takes place, water is injected into the drill hole to evacuate unwanted rock cuttings. Figure 1b shows the drill assembly of figure 1a wherein the drill steel has reached the limit of its travel and the bolt hole fully drilled. At this point the water has been cut off and the drilling halted. Figure 1c shows the drill steel removed and chemical sausage 7 prior to its installation in bolt hole 8. Once the chemical sausage has been inserted, a mixing dolly is installed as shown infigure 1d on chuck 5 of drilling rig 1 following which it is

advanced to and urged into hole 8 as shown in figure 1e whilst it is rotated for a predetermined time in order to mix the chemical in sausage 7. Once bolt 9 is fully inserted, rotation is halted whereupon it is left for enough time to allow the resin to set. As shown in figure 1f, the drilling rig is then retracted. The above described method is labour intensive and time consuming. On occasions, insertion of the chemical sausage can lead to delay as bunching might occur at the hole opening.

Figure 2 shows an exploded isometric view of a known roof bolter 10 including a drill head 11 according to a preferred embodiment of the invention. Drill head 11 may be adapted to roof bolter 10 via engaging plates 13. Thus, head 11 may be easily adapted to existing drilling equipment.

Figure 3 shows an enlarged partially cut away view of a drill head 20 according to one embodiment. Drill head 20 comprises housing block 21 including a gear box 22 which is connected to a drive motor incorporated in a drilling rig such as that shown in figure 2.

Gear box 22 further comprises drive system 22a and hydraulic motor 22b.

The head further comprises an offset drive spindle 23 including an integral drive chuck 24 which rotates responsive to operation of drive gears contained in gear box 22. Drive chuck 24 may be driven through either a gear system contained in gear box 22 or chain drive system (not shown).

Housing block 21 includes a network of passageways 25 which deliver drilling fluid from a reservoir passage 26 then to a self drilling bolt 30 seated in chuck 24. Housing block 21 further includes passageways 27 and 28 which receive and deliver constituents of a grouting compound 29 (see fig 6) which is to be injected into the rock bolt 30. Passageways 27 and 28 receive separate unmixed consitiuents of grouting compound 29 via feed ports 27a and 28. Injection into bolt 30 is facilitated by means of an injection nozzle 31 which is capable of advancing axially in the direction of bolt 30 and retracting away from bolt 30 depending upon which stage of operation the drill head 20 is engaged in. Injection nozzle 31 may comprise one only or multiple

passages which receive constituents of the compound. In the case of multiple it is preferable that these are isolated until such time as the constituents exit the nozzle and enter the internal passage 34 of bolt 30 whereupon the constituents will react to eventually set and secure thebolt in position. Advancement and retraction is preferably effected by a hydraulic piston 32 located in chamber 35. Offset drive spindle 23 further includes a sealing arrangement comprising a seal 33 which prevents unwanted escape of water from chuck 24 during drilling but allows communication between an internal passage 34 in bolt 30 and fluid passages 25 when injection nozzle 31 is retracted away from chuck 24.

In operation , the first stage of the drilling operation involves insertion of the self drilling rock bolt 30 into rock using a conventional drilling rig such as that described in figure 2.

During drilling, to ensure removal of debris from the the drill hole fluid such as water is pumped into passages 25 which empty the fluid into internal passage 34 of bolt 30 eventually exiting bolt 30 and entering a space between bolt 30 and the drilled bolt hole (not shown). The fluid passes over the leading end of injection nozzle 31. As the fluid exits the bolt hole it takes with it rock cuttings produced during drilling.

During this phase of operation, nozzle 31 is retracted away from drive spindle 23 and is inactive. Furthermore the nozzle is independant of rotation of the spindle 23 such that it is free from rotation during the drilling operation precluding the need for special sealing requirements to prevent escape of resin during drilling.

Once the hole is fully drilled the rock bolting can be completed without first having to retract the head away from the rock face as occured in the prior art to facilitate insertion of the bolt.

Refering to figure 4 there is shown a cross section of the head 20 of figure 3 with corresponding part numbering. Figure 4 shows the drilling cycle in which the self drilling bolt 30 is rotated by its engagement to drive socket 24 and the nozzle 31 retracted away from socket 24 but allowing

communication between passage 25 and internal passage 34 of bolt 30 thereby allowing free passage of fluid into passage 34 as previously described.

Figure 5 shows head 20 this time with fluid supply from passage 25 turned off and nozzle 31 advanced into engagement with chuck 24 thereby allowing injection of grouting compound 29 into passage 34 of bolt 30. The leading end of nozzle 31 seals passages 27 and 28 (see fig 4) from leakage such that their contents will discharge into passage 34 of bolt 30. Preferably, the grout is formed from a blend of resin mastic and resin catalyst which mix inside passage 34 of bolt 30 and are excluded from contact whilst in respective passages 27 and 28 of injection nozzle 31. The resin compound is fast curing allowing quicker completion of bolt anchorage.

Figure 6 shows the final stage of the drilling operation with injection nozzle 31 fully retracted and flushing fluid turned off. At this stage, the spindle is rotated in the opposite direction to that for drilling whereupon engagement between a nut on bolt 30 is tightened.

Figure 7 shows a cross sectional view of bolt 30 inserted in a rock stratum 37 secured by grouting compound 29. An advantage of the invention described with reference to the above embodiment is the provision of separate grout injection and fliud flushing systems in the drill head. The injection nozzle 31 functions as a shut off valve such that in the fully retracted position its internal passages are isolated from grout constituent passages 27 and 28.

The arrangement described above has numerous advantages over the prior art arrangements including: a minimum of moving parts, offset hollow drive spindle system, non rotating and self cleaning injection nozzle independant of the rotation of the spindle, use of the drilling fluid to clean the nozzle, the ablility of the nozzle to act as a shut off valve for grout injection.

It will be recognised by persons skilled in the art that numerous variations and modification may be made to the invention as broadly described herein , such as but not limited to;

a) use of alternative grouting compounds such as polyester resins, PVA, epoxy resins and any

single or multi component cement;

b) use of self drilled cable bolts, rods or tubes and indeed any form of rock bolt capable of use with the method and head described above;

c) use of injection needles or syringes and any fitting adapted to seal against any rock bolt capable of use with the assembly described;

d) automation of the system using a Programmable Logic Computer to govern and regulate drilling cycles and more particularly injection cycles;

without departing from the overall spirit and scope of the invention.

Dated this 31 day of MARCH 1999

Hydramatic Engineering Pty Ltd

By its Patent Attorneys

WALSH & ASSOCIATES

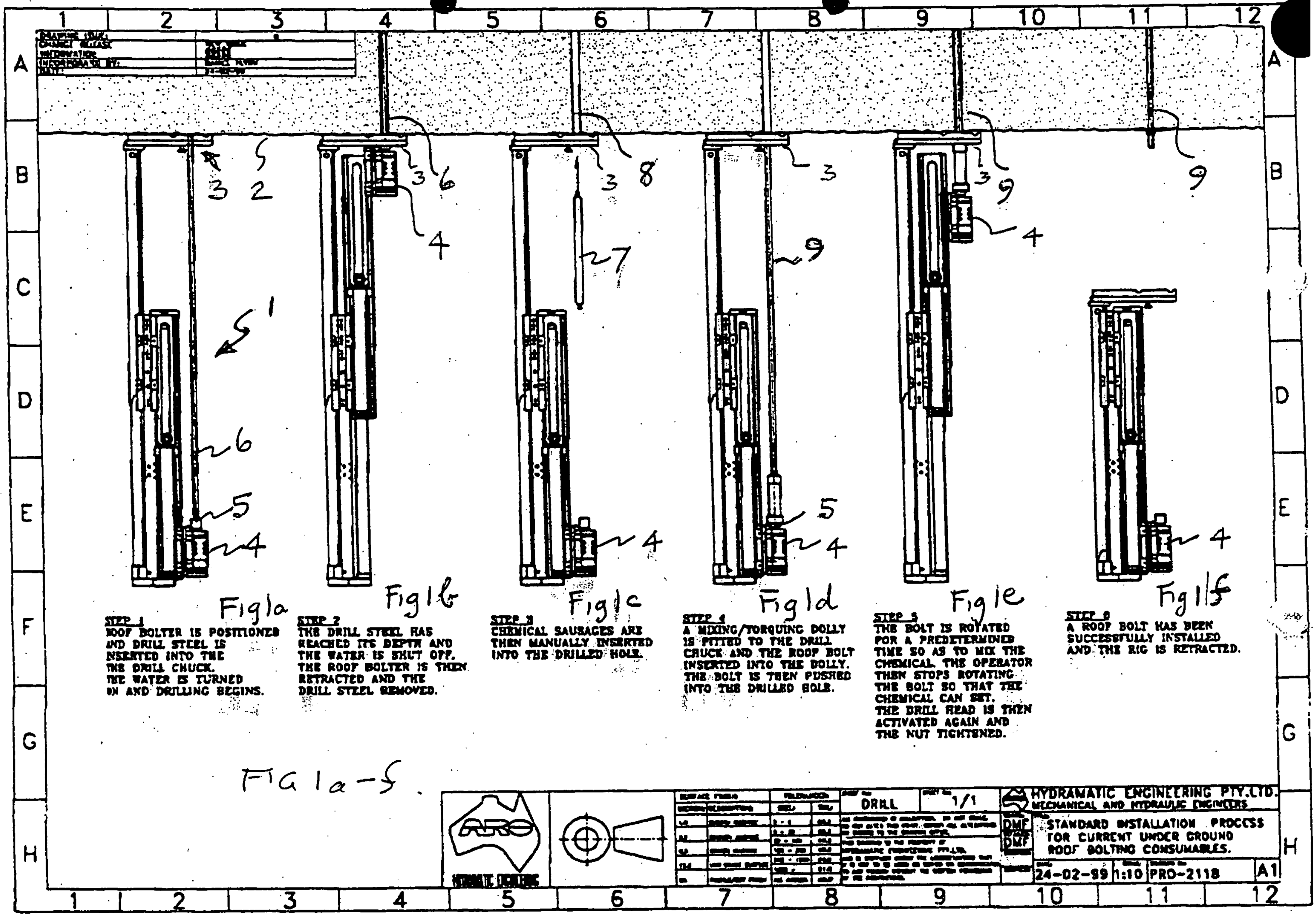
STEP 1
ROOF BOLTER IS POSITIONED AND DRILL STEEL IS INSERTED INTO THE DRILL CHUCK. THE WATER IS TURNED ON AND DRILLING BEGINS.
STEP 2
THE DRILL STEEL HAS REACHED ITS DEPTH AND THE WATER IS SHUT OFF. THE ROOF BOLTER IS THEN RETRACTED AND THE DRILL STEEL REMOVED.
STEP 3
CHEMICAL SAUSAGES ARE THEN MANUALLY INSERTED INTO THE DRILLED HOLE.
STEP 4
A MIXING/TORQUING DOLLY IS FITTED TO THE DRILL CHUCK AND THE ROOF BOLT INSERTED INTO THE DOLLY. THE BOLT IS THEN PUSHED INTO THE DRILLED HOLE.
STEP 5
THE BOLT IS ROTATED FOR A PREDETERMINED TIME SO AS TO MIX THE CHEMICAL. THE OPERATOR THEN STOPS ROTATING THE BOLT SO THAT THE CHEMICAL CAN SET. THE DRILL HEAD IS THEN ACTIVATED AGAIN AND THE NUT TIGHTENED.
STEP 6
A ROOF BOLT HAS BEEN SUCCESSFULLY INSTALLED AND THE RIG IS RETRACTED.
Fig 1a
Fig 1b
Fig 1c
Fig 1d
Fig 1e
Fig 1f
DRILL
1/1
HYDRAMATIC ENGINEERING PTY.LTD.
MECHANICAL AND HYDRAULIC ENGINEERS
STANDARD INSTALLATION PROCESS FOR CURRENT UNDER GROUND ROOF BOLTING CONSUMABLES.
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FIG 1a-f.

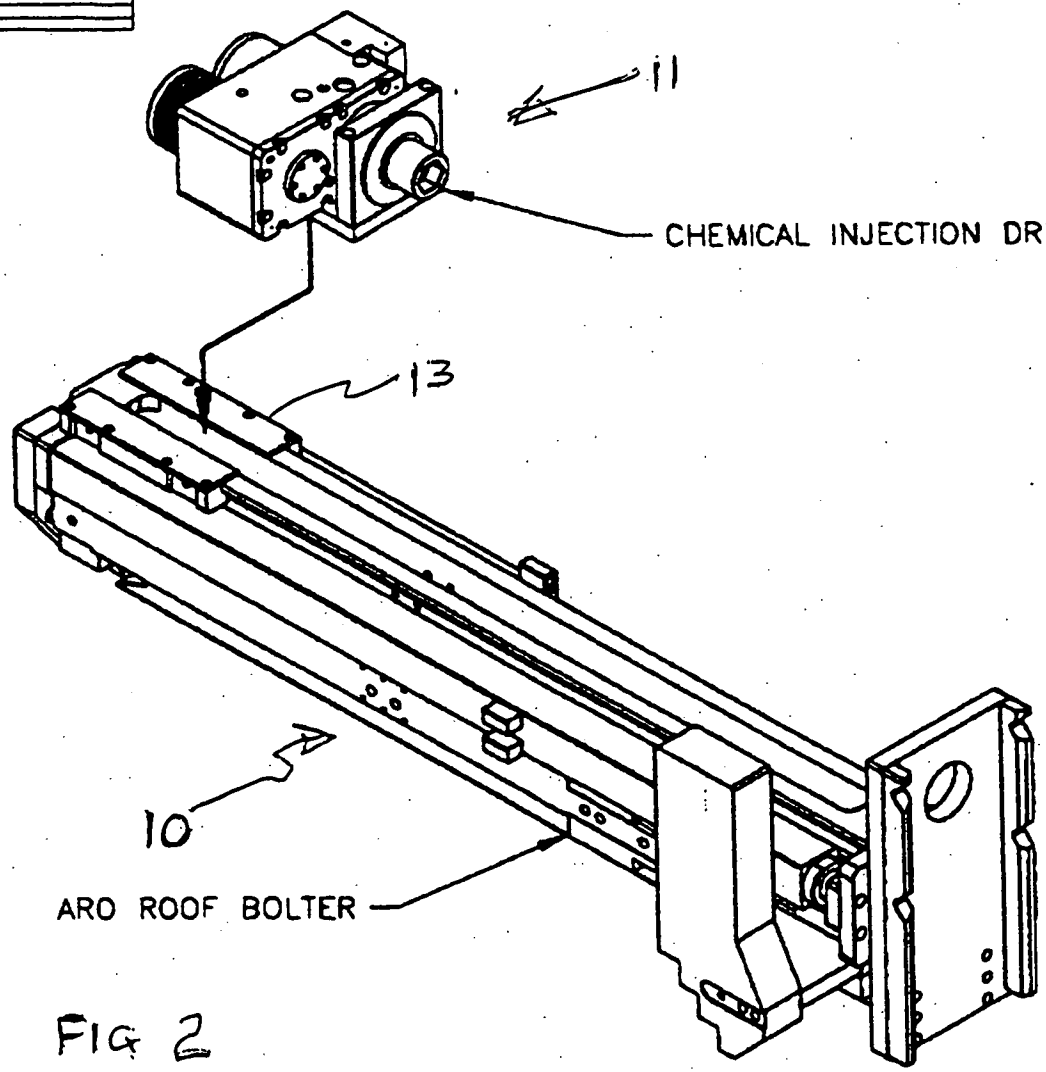

FIG 2

HYDRAMATIC ENGINEERING PTY.LTD.
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DRILL 1/1

ASSEMBLY,
ROOF BOLTER WITH
CHEMICAL INJECTION CONFIGURATION.

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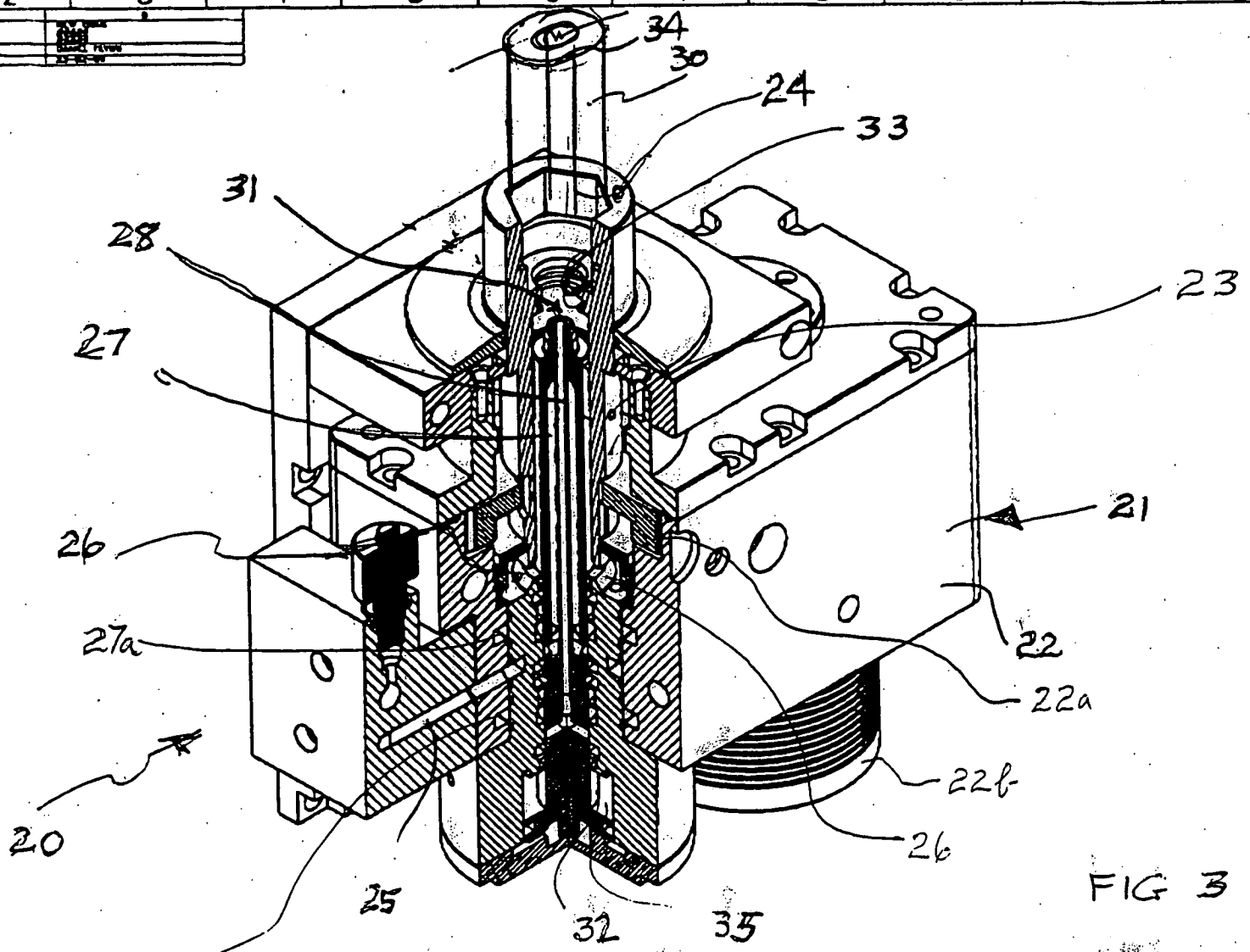

FIG 3

1	2	3	4	5	6	7	8	9	10	11	12		

1	2	3	4	5	6	7	8	9	10	11	12		

DRILL 1/1

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ASSEMBLY,
1/4 SECTION ISO VIEW,
CHEMICAL INJECTION DRILL HEAD.

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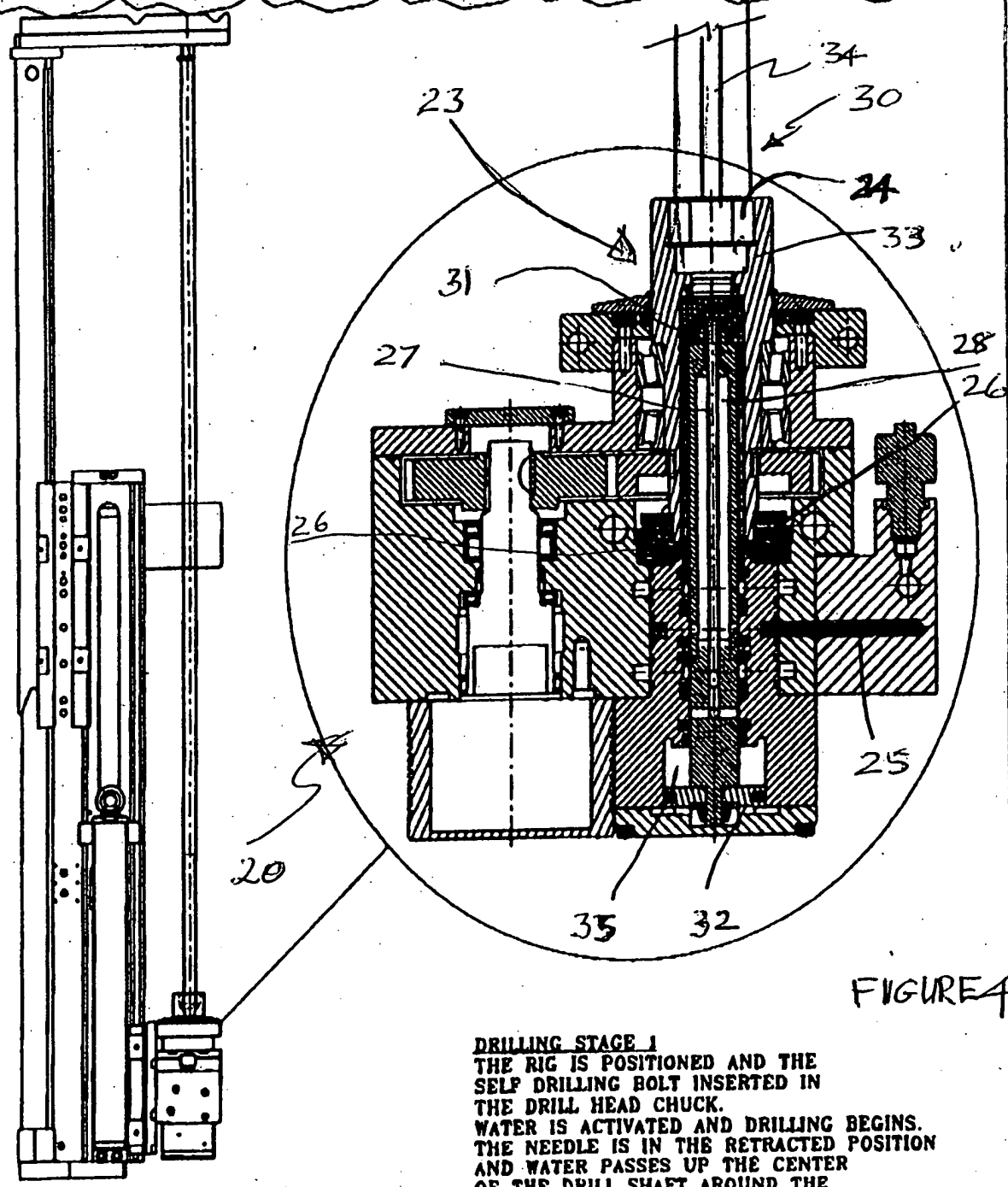

FIGURE 4

DRILLING STAGE 1
THE RIG IS POSITIONED AND THE SELF DRILLING BOLT INSERTED IN THE DRILL HEAD CHUCK.
WATER IS ACTIVATED AND DRILLING BEGINS.
THE NEEDLE IS IN THE RETRACTED POSITION AND WATER PASSES UP THE CENTER OF THE DRILL SHAFT AROUND THE INJECTION NEEDLE AND UP THROUGH THE ROCK BOLT.

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DRILLING 1/4

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STAGE 1.
BOLT INSTALLATION USEING THE CHEMICAL INJECTION DRILL HEAD.

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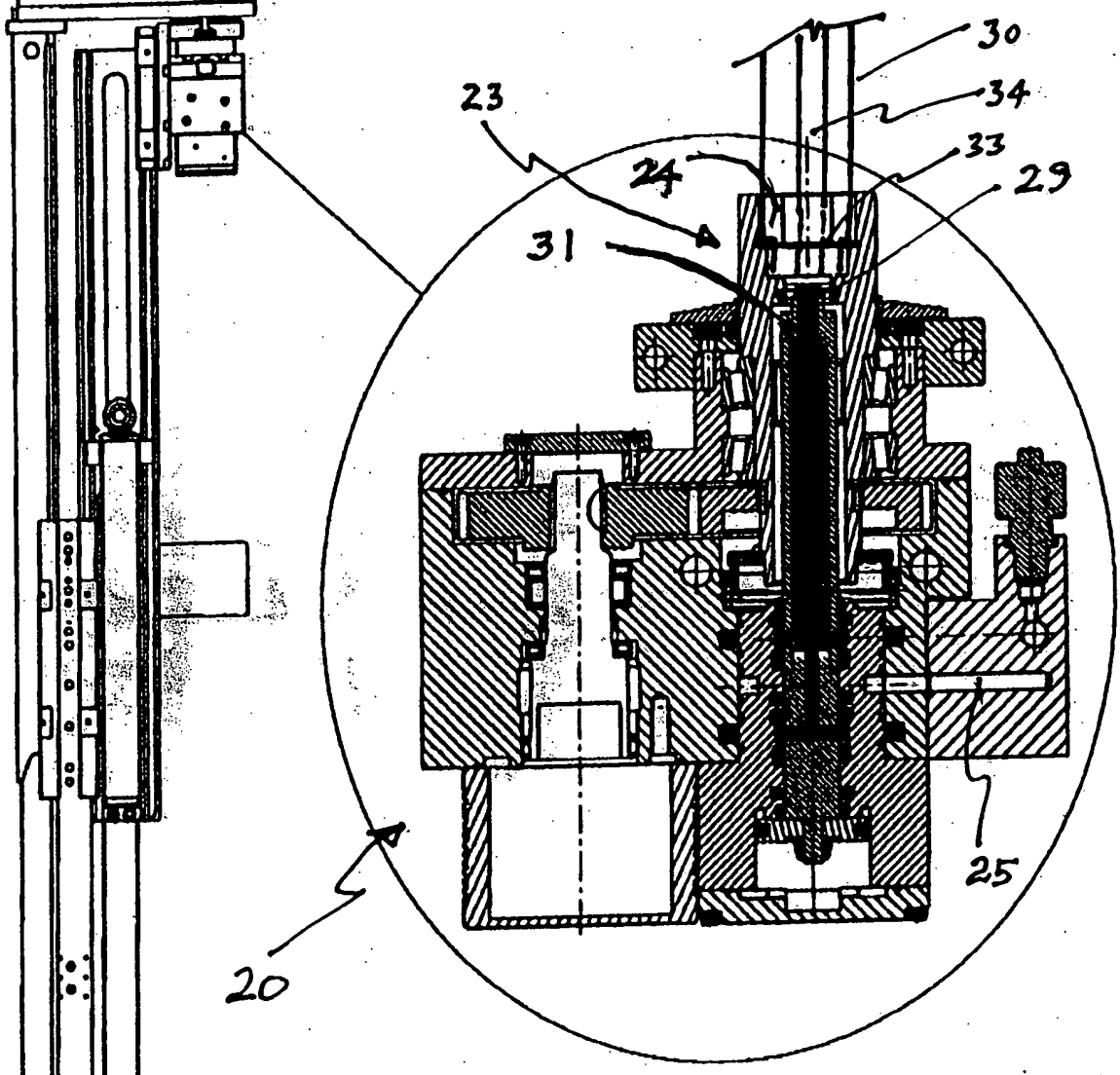

FIG 5

CHEMICAL INJECTION STAGE 2
CHEMICAL IS FORCED UNDER PRESSURE THROUGH SEPARATE CHAMBERS OF THE CHEMICAL INJECTION NEEDLE.
THE NEEDLE IS POSITIONED IN THE REAR OF THE SELF DRILLING BOLT WHERE THE CHEMICALS FIRST BEGIN TO MIX. THE OPERATOR WAITS FOR CHEMICAL TO FLOW OUT OF THE HOLE IN THE ROOF THEN HITS THE STOP INJECTION BUTTON. THE OPERATOR THEN WAITS FOR THE CHEMICAL TO SET.

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DRILLING 2/4

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STAGE 2.
BOLT INSTALLATION USEING THE CHEMICAL INJECTION DRILL HEAD.

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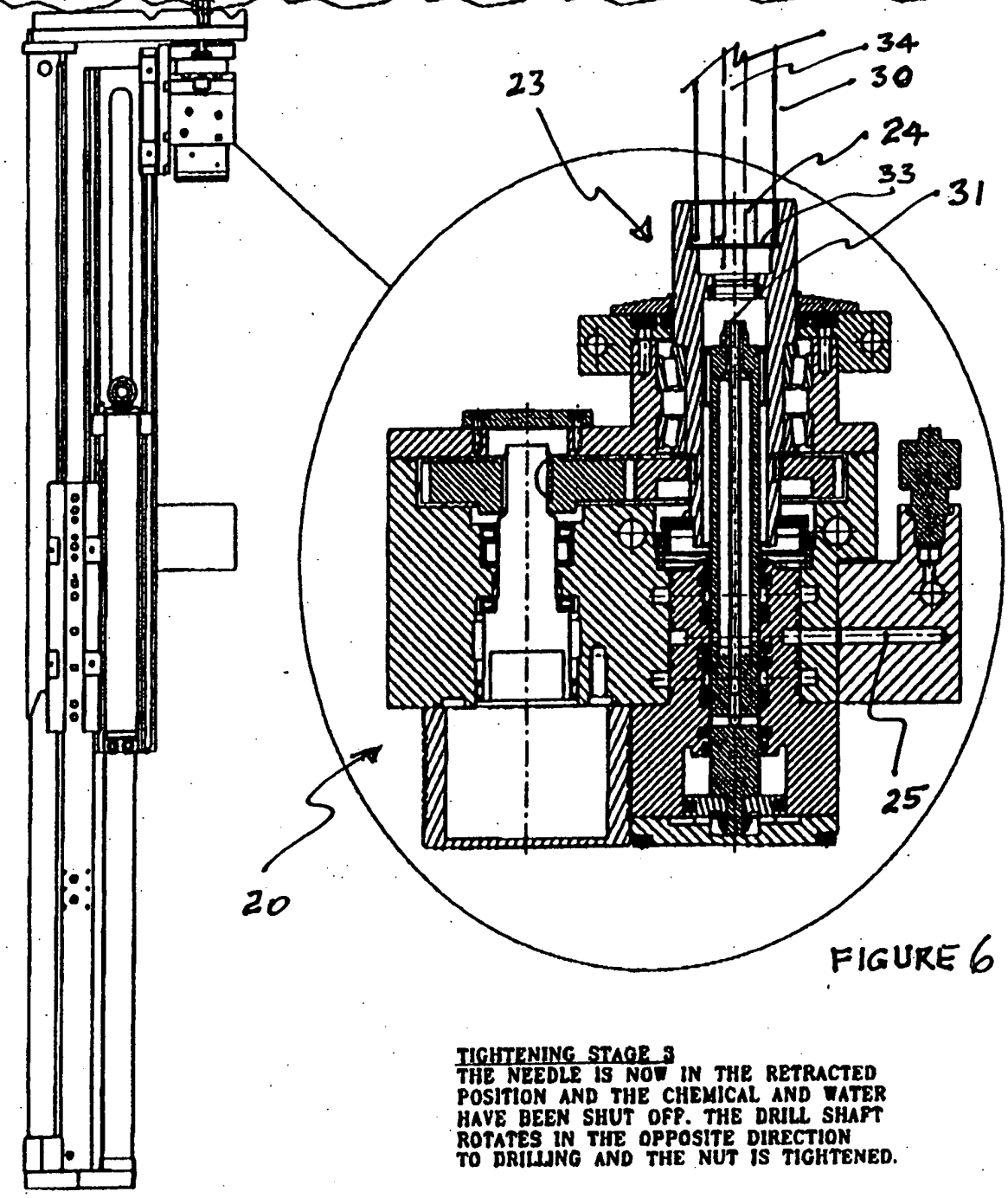

FIGURE 6

TIGHTENING STAGE 3
THE NEEDLE IS NOW IN THE RETRACTED POSITION AND THE CHEMICAL AND WATER HAVE BEEN SHUT OFF. THE DRILL SHAFT ROTATES IN THE OPPOSITE DIRECTION TO DRILLING AND THE NUT IS TIGHTENED.

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DRILLING 3/4

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STAGE 3,
BOLT INSTALLATION USEING THE CHEMICAL INJECTION DRILL HEAD.

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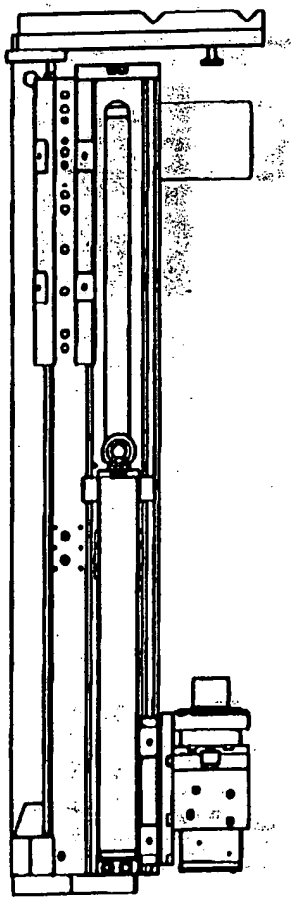

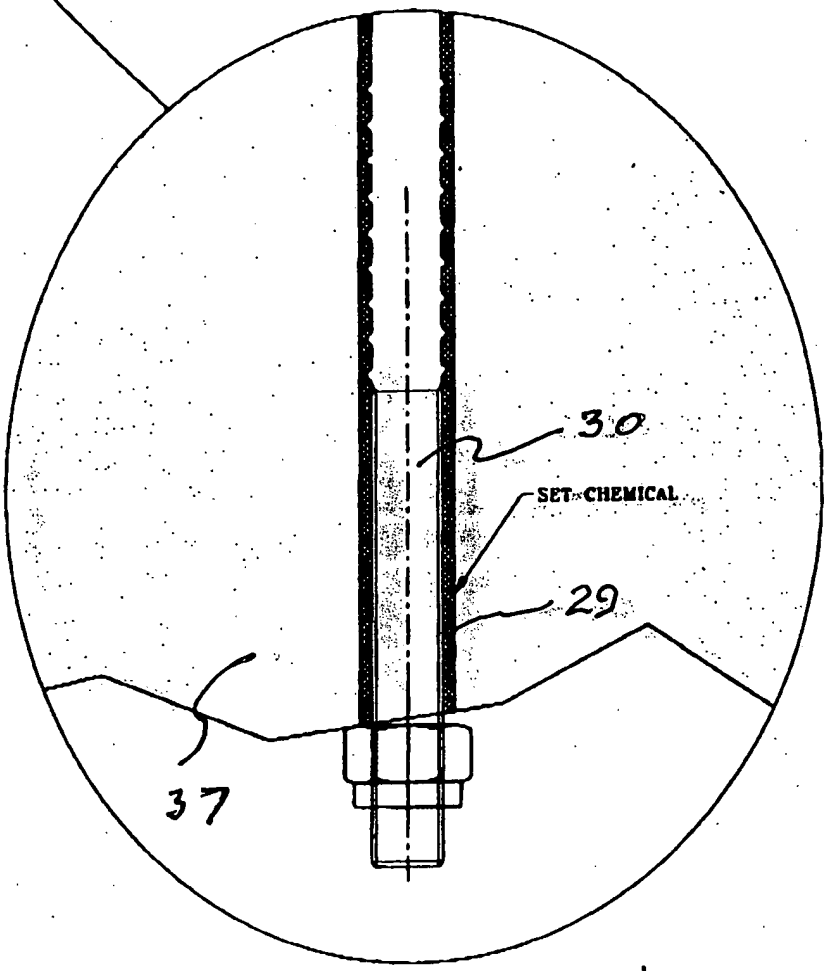

FIGURE 7

BOLT FULLY INSTALLED
THE RIG RETRACTS AND THE BOLT
HAS BEEN FASTENED IN THE ROOF.

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DRILLING 4/4

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STAGE 4.
BOLT INSTALLATION USEING THE
CHEMICAL INJECTION DRILL HEAD.

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